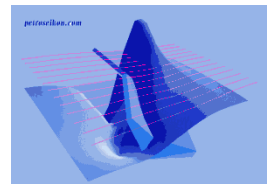


3D RESISTIVITY INVERSION TUTORIAL

Steps:

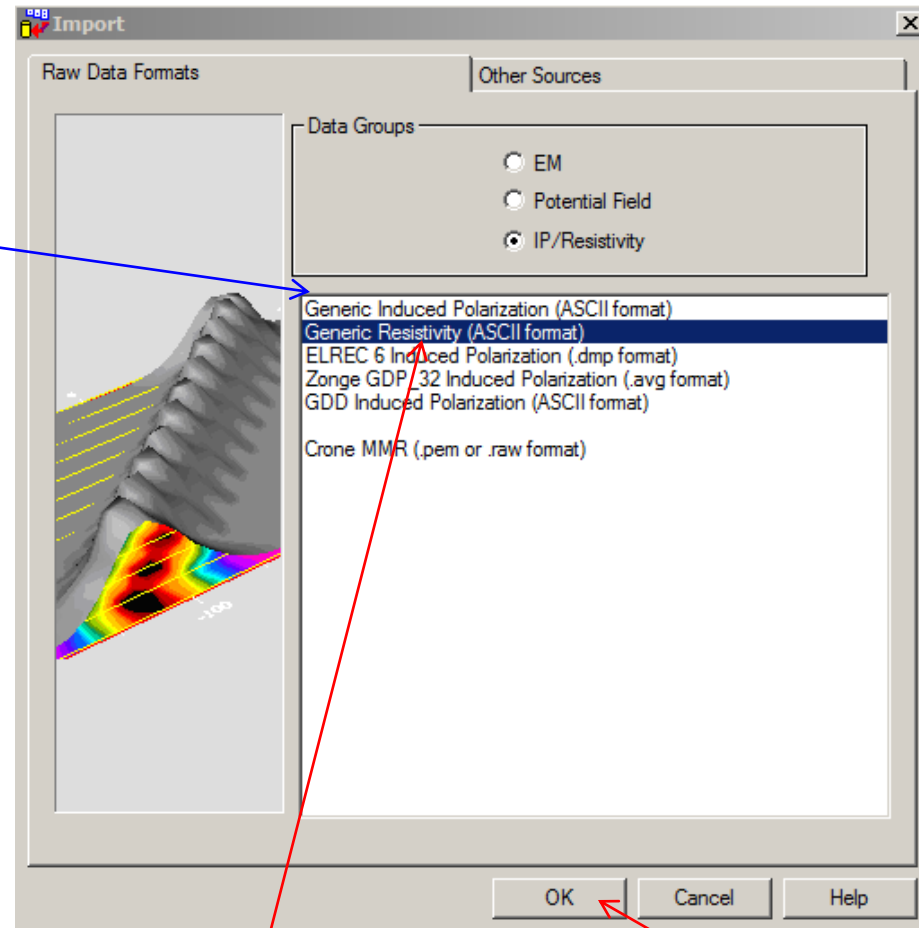
	<i>Page</i>
1. Import data to new or existing database	2
2. Examine data	6
3. Perform initial forward modeling	8
4. Perform 3D resistivity inversions	9
5. Check model and create plots	16



1. Import data

2. Examine data
3. Perform initial modeling
4. Perform 3D resistivity inversions
5. Check model and create plots

Select “Generic Induced Polarization” if your data is from IP survey



Select “Generic Resistivity” and click “OK” button

1. Import data

2. Examine data
3. Perform initial modeling
4. Perform 3D resistivity inversions
5. Check model and create plots

Browse and select data file for import

Inputs. Import Wizard. Setup 1.

File Name: E:\Importdata\Resistivity\Titan\L-69743N_ong_qct_work_east_flip_nodupl.xyz Browse

Select one line as a header line

(0)	C2Y(0)	P1X(0)	P1Y(0)	P2X(0)	P2Y(0)
-	79773.00	41200.00	69743.00	41400.00	6974
-	79773.00	41200.00	69743.00	41400.00	6974
-	79773.00	41400.00	69743.00	41600.00	6974
-	79773.00	41200.00	69743.00	41400.00	6974
-	79773.00	41400.00	69743.00	41600.00	6974
-	79773.00	41200.00	69743.00	41400.00	6974
-	79773.00	41600.00	69743.00	41800.00	6974

Reset a Header
Select a header line with the column labels and click on Reset button
Reset

Resistivity Only (Static Domain) or Resistivity/Phase (Frequency Domain)

General information from file

Electrode Array Selection

Dipole - Dipole
 Pole - Dipole
 Pole - Pole
 Gradient

Distance to infinity Pole(m): 10000

Time base (mSec): 0
Dipole Length: 200
Number of Windows: 1
Reference Point at: Centre point

Line Direction

East-West
 North-South

Line label in selected column
2 C1Y(0)

Output Normalization

Normalize to current (Resistivity)
 Normalize to primary voltage (IP)

< Back Next > Cancel Help

Select electrode array type and set the distance to infinity pole

Set line direction and select the data column for the line

Set dipole length and reference point position

Click "Next" button to proceed to next step

1. Import data

2. Examine data
3. Perform initial modeling
4. Perform 3D resistivity inversions
5. Check model and create plots

Select vertices for both transmitter and receiver, as well as the units of coordinate

Select the column which contains voltage data and set its units

Data Information. Import Wizard. Step 2.

File View

C1X()	C1Y()	C2X()	C2Y()	P1
41500.00	69743.00	.	79773.00	
41700.00	69743.00	.	79773.00	
41700.00	69743.00	.	79773.00	

Time delay:

On-Time window:

Window centre(s):

Window width:

System

Transmitter Vertices:

Electrode 1:

Electrode 2:

Receiver Vertices:

Electrode 1:

Electrode 2:

Coordinate Units

meters

feet

Voltage:

Units

mVolts Volts

Apparent Resistivity

Current:

Units

mAmp Amp

Phase

Phase Units

Degree Rad mRad

Frequency (Hz):

Units

	Column #.	Window width	Column #.	Window width	
<input type="checkbox"/>	Window 1	<input type="text" value="0"/>	<input type="checkbox"/>	Window 11	<input type="text" value="0"/>
<input type="checkbox"/>	Window 2	<input type="text" value="0"/>	<input type="checkbox"/>	Window 12	<input type="text" value="0"/>
<input type="checkbox"/>	Window 3	<input type="text" value="0"/>	<input type="checkbox"/>	Window 13	<input type="text" value="0"/>
<input type="checkbox"/>	Window 4	<input type="text" value="0"/>	<input type="checkbox"/>	Window 14	<input type="text" value="0"/>
<input type="checkbox"/>	Window 5	<input type="text" value="0"/>	<input type="checkbox"/>	Window 15	<input type="text" value="0"/>
<input type="checkbox"/>	Window 6	<input type="text" value="0"/>	<input type="checkbox"/>	Window 16	<input type="text" value="0"/>
<input type="checkbox"/>	Window 7	<input type="text" value="0"/>	<input type="checkbox"/>	Window 17	<input type="text" value="0"/>
<input type="checkbox"/>	Window 8	<input type="text" value="0"/>	<input type="checkbox"/>	Window 18	<input type="text" value="0"/>
<input type="checkbox"/>	Window 9	<input type="text" value="0"/>	<input type="checkbox"/>	Window 19	<input type="text" value="0"/>
<input type="checkbox"/>	Window 10	<input type="text" value="0"/>	<input type="checkbox"/>	Window 20	<input type="text" value="0"/>

Data Units:

mV/V V/V mSec

Time Window Units:

mSec Sec

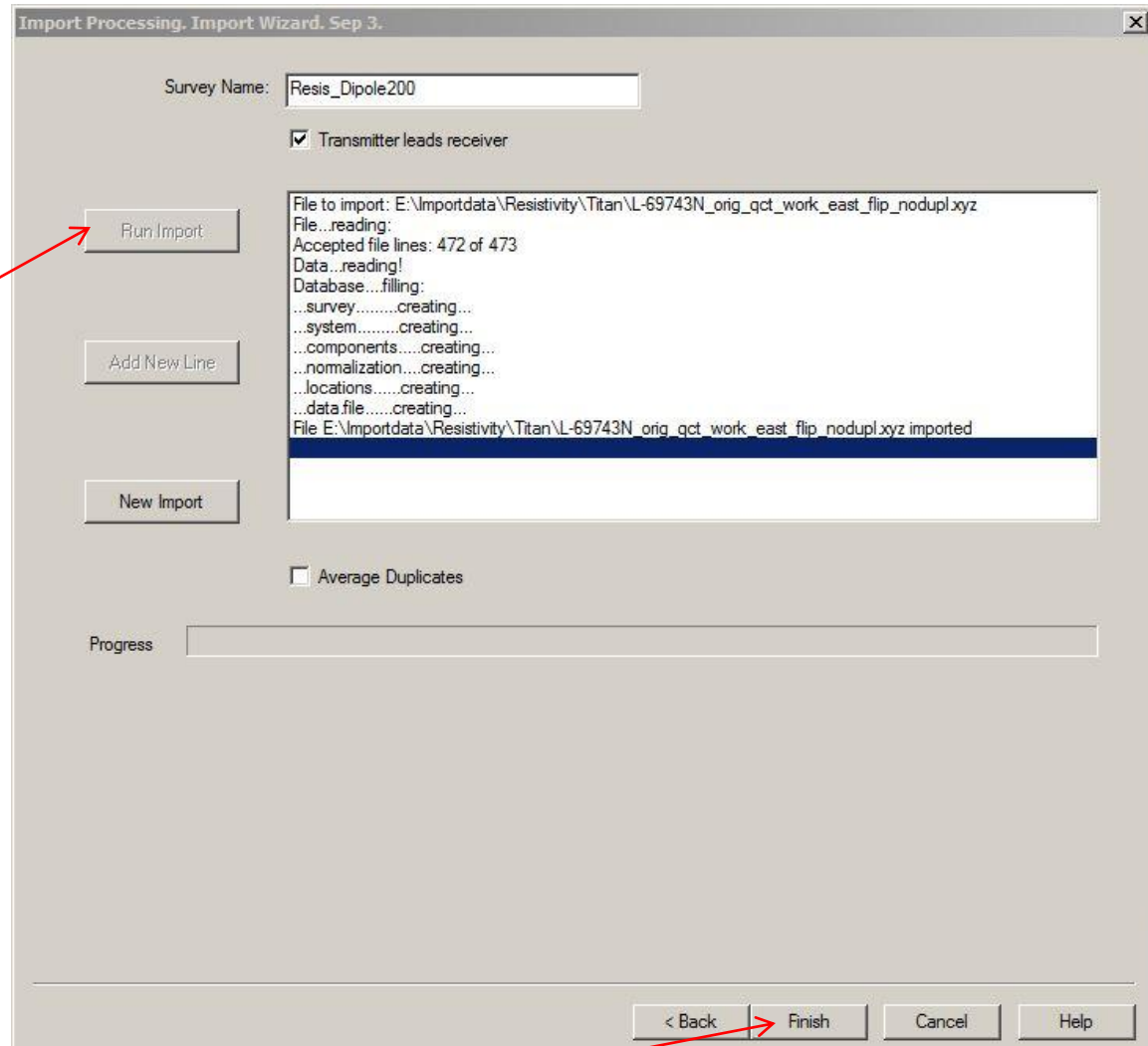
< Back **Next >** Cancel Help

Click "Next" button to proceed to the next step

1. Import data

2. Examine data
3. Perform initial modeling
4. Perform 3D resistivity inversions
5. Check model and create plots

Click “Run Import” button to start importing data into database



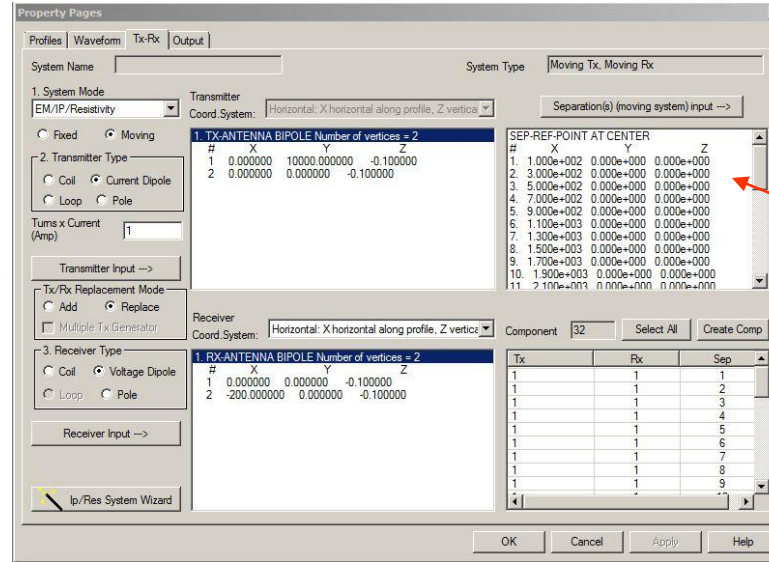
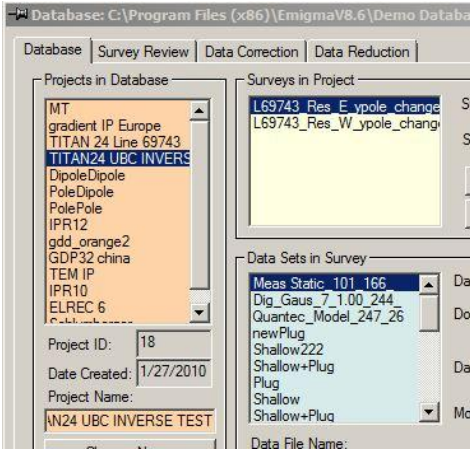
After processing is done, click “Finish” button to complete the import procedure

1. Import data
2. Examine data
3. Perform initial modeling
4. Perform 3D resistivity inversions
5. Check model and create plots

Resistivity Inverse

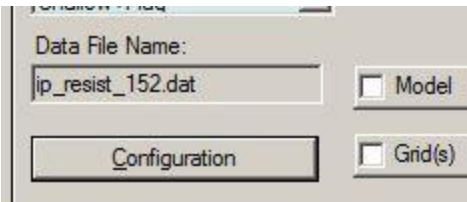
6

1. Check database for the survey

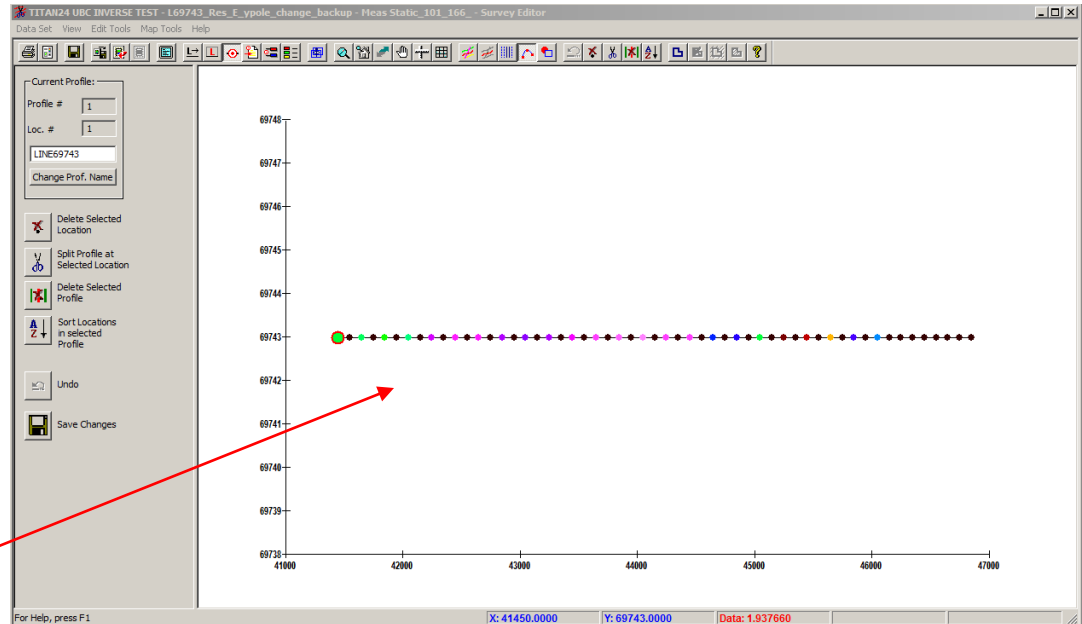


3. Check separations

2. Click configuration



4. Check lines and stations by clicking "Survey Editor" button

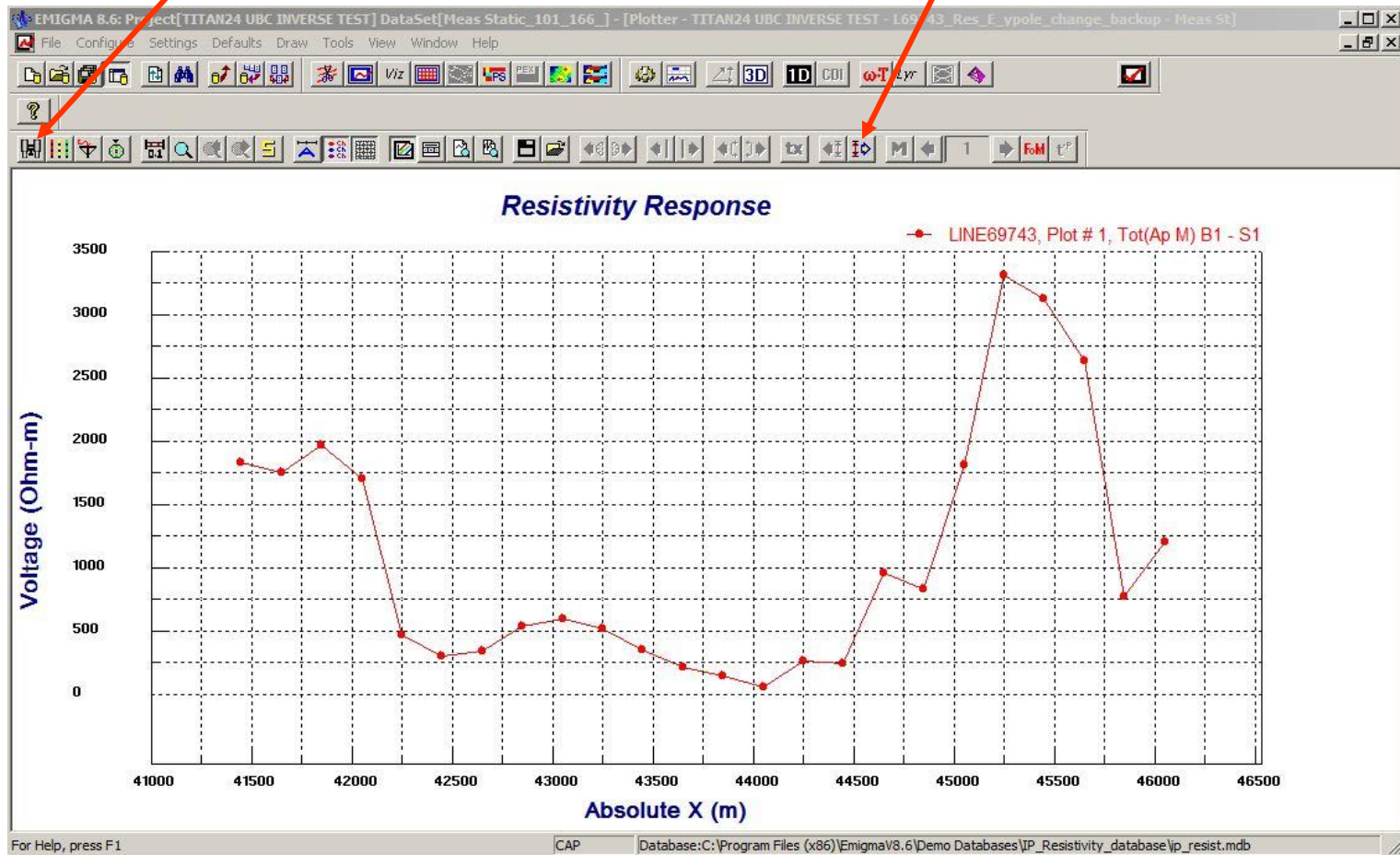


1. Import data
- 2. Examine data**
3. Perform initial modeling
4. Perform 3D resistivity inversions
5. Check model and create plots



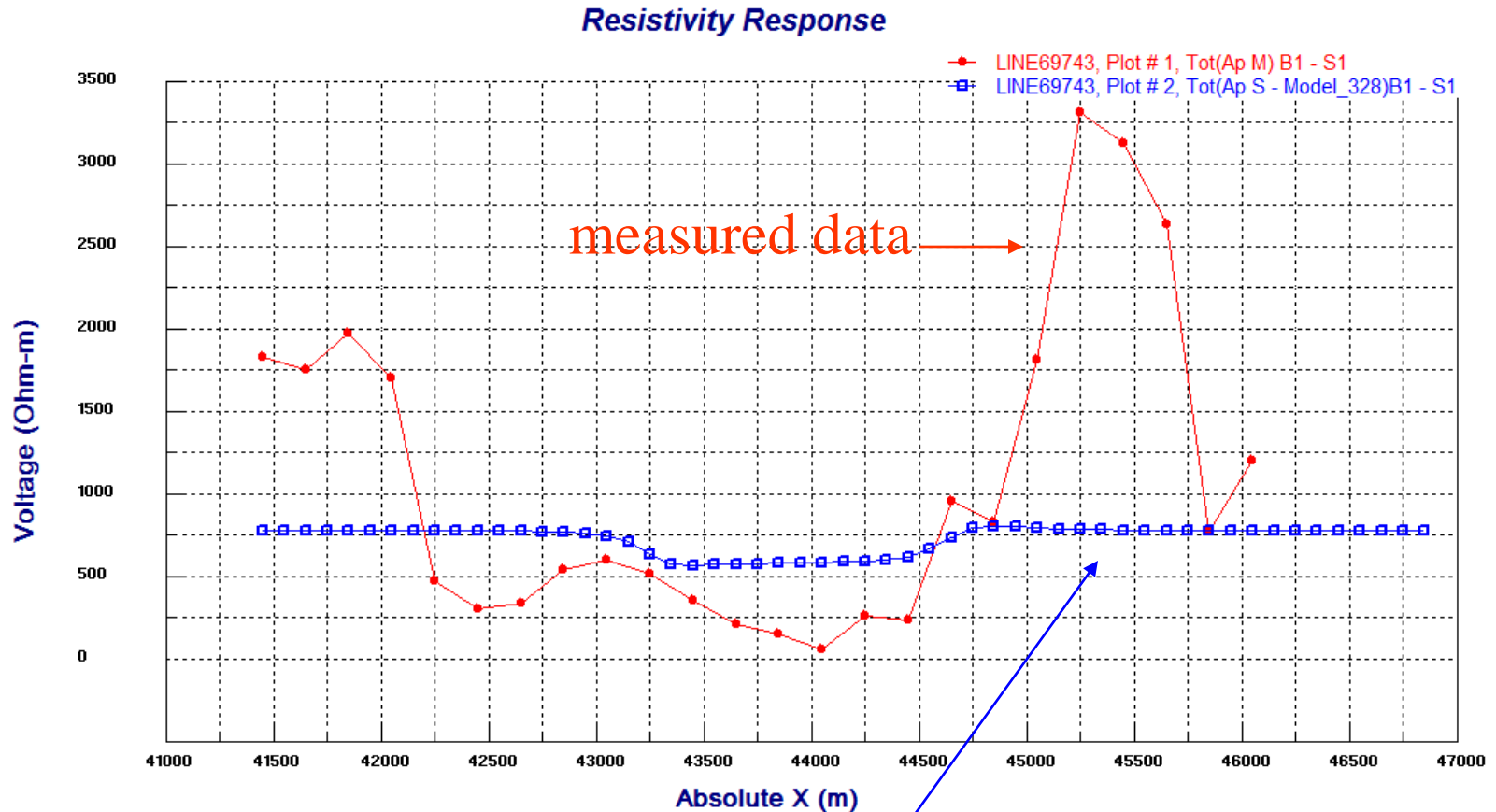
Load data set in plotter

Toggle between separations



1. Import data
2. Examine data
- 3. Perform initial modeling**
4. Perform 3D resistivity inversions
5. Check model and create plots

Note: *Performed some initial modeling to get a “feel” of the background resistivity and estimate parameters of initial model for inversion.*



1. Import data
2. Examine data
3. Perform initial modeling
- 4. Perform 3D resistivity inversions**
5. Check model and create plots

The image shows a workflow for performing a 3D resistivity inversion. On the left, a 'Data Sets in Survey' window lists several data sets. A red arrow points from the text 'Select measured data' to the 'Meas Static_101_166' entry. An arrow points from this window to a toolbar where the '3D' button is circled in red. Another arrow points from the toolbar to the main 'Resistivity 3D Inversion' dialog box.

Select measured data

The 'Resistivity 3D Inversion' dialog box contains the following settings:

- Flip data sign
- Forward Method:** Born Superposition LN
- Component and Weight:** Select button, No. of Selected Component: 32
- Background Layers:** Set Layer Model, Set Layers button, No. of Layers: 1
- Use Initial Model, Set Initial Model button
- Inversion Parameters:** Target Misfit: 5, Max iterations: 20, Smoothness: 0.5, Get Settings From a Log File button
- Search Volume:** Center X: 44150, Center Y: 69743, Top Z: -1, Horizontal Angle (degree): 0, Size X: 5300, Size Y: 2650, Thickness: 9450, Select search area button, Select survey area button
- Grid Settings:** Cells in X: 106, Cell size X: 50, Spacing Z direction: Evenly Exponentially (based on Z), Cells in Y: 1, Cell size Y: 2650, Cells in Z: 378, Top cell thickness: 25, Total: 40068, Cell Sampling: X: 1, Y: 1, Z: 1
- Output Model Resistivity Constraint (Dhm²m):** Sensitivity: 1e-006, Min: 54, Max: 5485, Remove cells between, Min: 1328.4, Max: 1623.6, Output cells: 40068
- Inversion Message:** Empty text area
- Progress:** Progress bar
- Close application when inversion completes
- Buttons: Run, Close, Help

1. Import data
2. Examine data
3. Perform initial modeling
- 4. Perform 3D resistivity inversions**
5. Check model and create plots

Set search volume and grid:

User can input the search volume's center position (X, Y), top Z position and horizontal angle with the coordinate, also the volume's regime on X and Y axis as well as its thickness. User can also manually select the search area on the graphic tool by clicking the "Select search area" button

User can set grid by input cell size on X, Y and Z axis as well as number of cells in Z (can be evenly or exponentially spaced). The sampling rate of cells for all axes can be set in "Cell Sampling" area

The screenshot shows the 'Resistivity 3D Inversion' dialog box with the following settings and annotations:

- Flip data sign:** (Annotated: Choose "Flip data sign" option if it is not in accordance with system)
- Forward Method:** Born, Superposition LN (Annotated: Select forward simulation method: Born approximation or Superposition LN)
- Component and Weight:** Select button (Annotated: Select components for inversion and assign weights on them)
- No. of Selected Component:** 32 (Annotated: Set background layers parameters (resistivity and thickness) within which the model situated)
- Background Layers:** Set Layer Model, Set Layers button, No. of Layers: 1 (Annotated: Create or import initial model for inversion in the pop-up dialog)
- Use Initial Model:** (Annotated: Set constraint for output model's resistivity to exclude inverted models with unwanted resistivity values)
- Set Initial Model:** Button
- Search Volume:**
 - Center X: 44150, Center Y: 69743, Top Z: -1, Horizontal Angle (degree): 0
 - Size X: 5300, Size Y: 2650, Thickness: 9450
 - Buttons: Select search area, Select survey area
- Grid Settings:**
 - Cells in X: 106, Cell size X: 50, Spacing Z direction: Evenly, Exponentially (based on 2)
 - Cells in Y: 1, Cell size Y: 2650
 - Cells in Z: 378, Top cell thickness: 25
 - Total: 40068
 - Cell Sampling: X: 1, Y: 1, Z: 1
- Output Model Resistivity Constraint (Ohm*m):**
 - Sensitivity: 1e-006, Min: 54, Max: 5485
 - Remove cells between: Min: 1328.4, Max: 1623.6, Output cells: 40068
- Inversion Parameters:** Target Misfit: 5, Max iterations: 20, Smoothness: 0.5 (Annotated: User can also remove model cells whose resistivity values are within a certain range to accelerate processing)
- Get Settings From a Log File:** Button
- Inversion Message:** Empty text area
- Progress:** Progress bar
- Close application when inversion completes:** (Annotated: Set inversion parameters: tolerant data error (Target Misfit), maximum number of iterations (Max iterations) and Smoothness of the model)
- Buttons:** Run, Close, Help

Choose "Flip data sign" option if it is not in accordance with system

Select forward simulation method: Born approximation or Superposition LN

Select components for inversion and assign weights on them

Set background layers parameters (resistivity and thickness) within which the model situated

Create or import initial model for inversion in the pop-up dialog

Set constraint for output model's resistivity to exclude inverted models with unwanted resistivity values

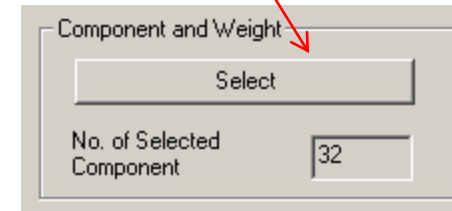
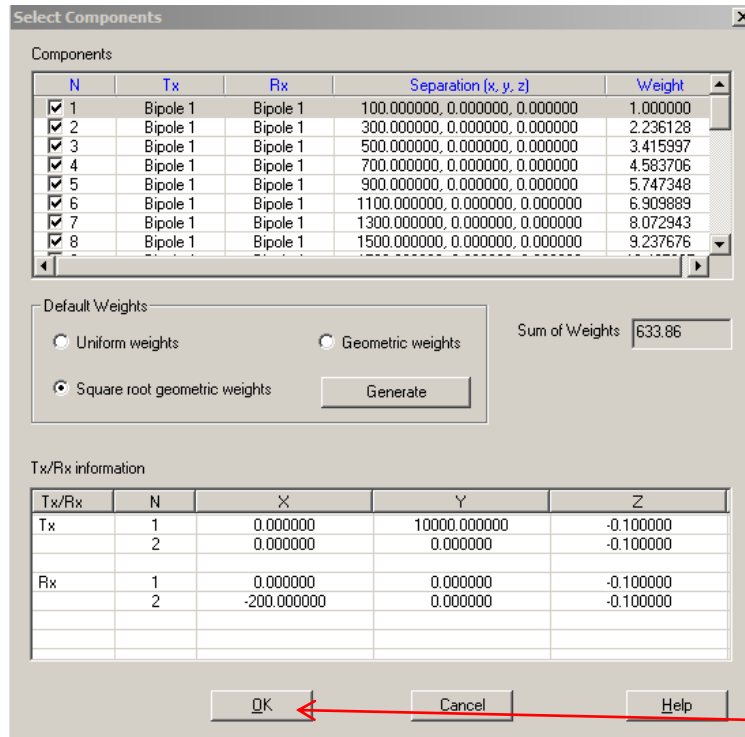
User can also remove model cells whose resistivity values are within a certain range to accelerate processing

Set inversion parameters: tolerant data error (Target Misfit), maximum number of iterations (Max iterations) and Smoothness of the model

1. Import data
2. Examine data
3. Perform initial modeling
- 4. Perform 3D resistivity inversions**
5. Check model and create plots

Selection of components

Click "Select" button

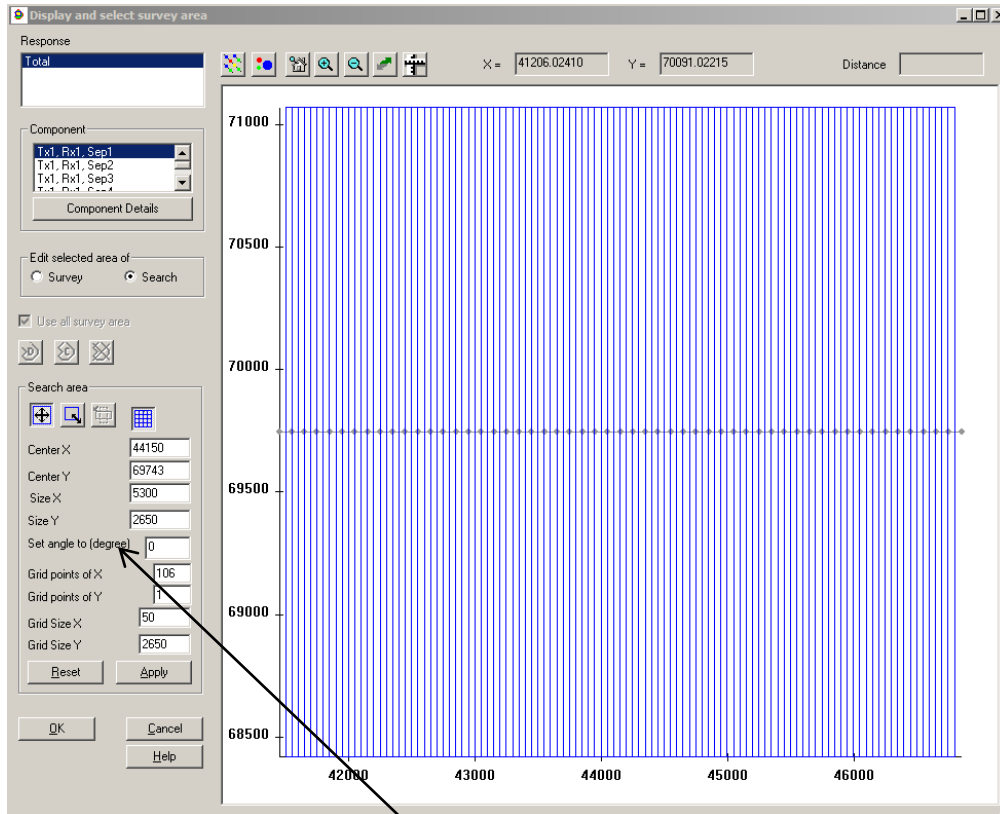


Click "OK" button after it is done

Users can select components involved with inversion. For the case of 3D resistivity inversion, different components are actually different separations. Users can also give weightings to different components. Use more components in inversion will make the inverted model more accurate

1. Import data
2. Examine data
3. Perform initial modeling
4. Perform 3D resistivity inversions
5. Check model and create plots

Clicking either the **Select Search Area** or **Select Survey Area** buttons launches the same window. But search area means the area of data which the inversion algorithm works on, while survey area is the whole part of the imported data.



Survey Area

Click the Select survey area button to launch the graphical tool which enables you to specify the data points that will be used in the inversion calculations.

Search Volume

The default parameters in the **Search Volume** section will create a grid that covers the entire survey. You can modify the search area parameters by entering new values or by using the graphical tool

If change the value in “Set angle to (degree)” box, the angle between search area and survey area will be changed accordingly

1. Import data
2. Examine data
3. Perform initial modeling
- 4. Perform 3D resistivity inversions**
5. Check model and create plots

Grid Settings

Cells in X	106	Cell size X	50	Spacing Z direction	Cell Sampling
Cells in Y	1	Cell size Y	2650	<input checked="" type="radio"/> Evenly	
Cells in Z	17	Top cell thickness	555.882	<input type="radio"/> Exponentially (based on 2)	
Total	40068				
				X	1
				Y	1
				Z	1

Grid Settings

Confirm the number and layout of grid points to be used in the inversion in the **Grid Settings** area. The points will be evenly spaced in the x and y directions. Choose **Evenly** for evenly spaced points in the z direction or **Exponentially (based on 2)** for exponentially spaced points.

Cell Sampling

Grid cells can be divided into smaller units when calculate the simulated data. Type your values in the **X**, **Y** and **Z** boxes to specify the number of samples in the X, Y and Z directions

1. Import data
2. Examine data
3. Perform initial modeling
- 4. Perform 3D resistivity inversions**
5. Check model and create plots

The screenshot shows the 'Set Initial Model' dialog box. It has a 'Build a model' section with the following fields:

- Size (m): X=5300, Y=2650, Z=9450
- Center (m): X=44150, Y=69743, Z=-4726
- Euler Angles (degree): 1st=0, 2nd=0, 3rd=0
- Conductivity: 0.01

Buttons in the dialog include 'Add a prism', 'Set size to all selected prisms', 'Set angles to all selected prisms', 'Set conductivity to all selected prisms', 'Import a model', and 'Delete all selected prisms'. Below the dialog is an 'Initial Model' table with the following columns: #, Conductivity, 1st Angle (degree), 2nd Angle (degree), 3rd Angle (degree), Size X (m), Size Y (m), and Si. The table is currently empty, displaying 'There are no items to show in this view.' At the bottom of the dialog are 'OK', 'Cancel', and 'Help' buttons.

Initial Model

Click the checkbox labeled **Use Initial Model** to specify an initial model. Return to the initial model window by clicking the **Set Initial Model** button.

The starting model is described by a list of prisms with various properties in the box labeled **Initial Model**.

add a prism to the model list

Specify the conductivity, size, position and orientation of the new prism in the **Build a model** section.

Click the **Add a prism** button.

modify an existing prism in the model list

Select the number of the prism to be modified in the anomaly list, and double-click the parameters to make modification directly.

apply the same values for a group of selected prisms

Click the **Set conductivity to all selected prisms** button to modify the conductivity.
 Click the **Set angles to all selected prisms** button to modify the angles.
 Click the **Set size to all selected prisms** button to modify the size.

delete prisms from the model list

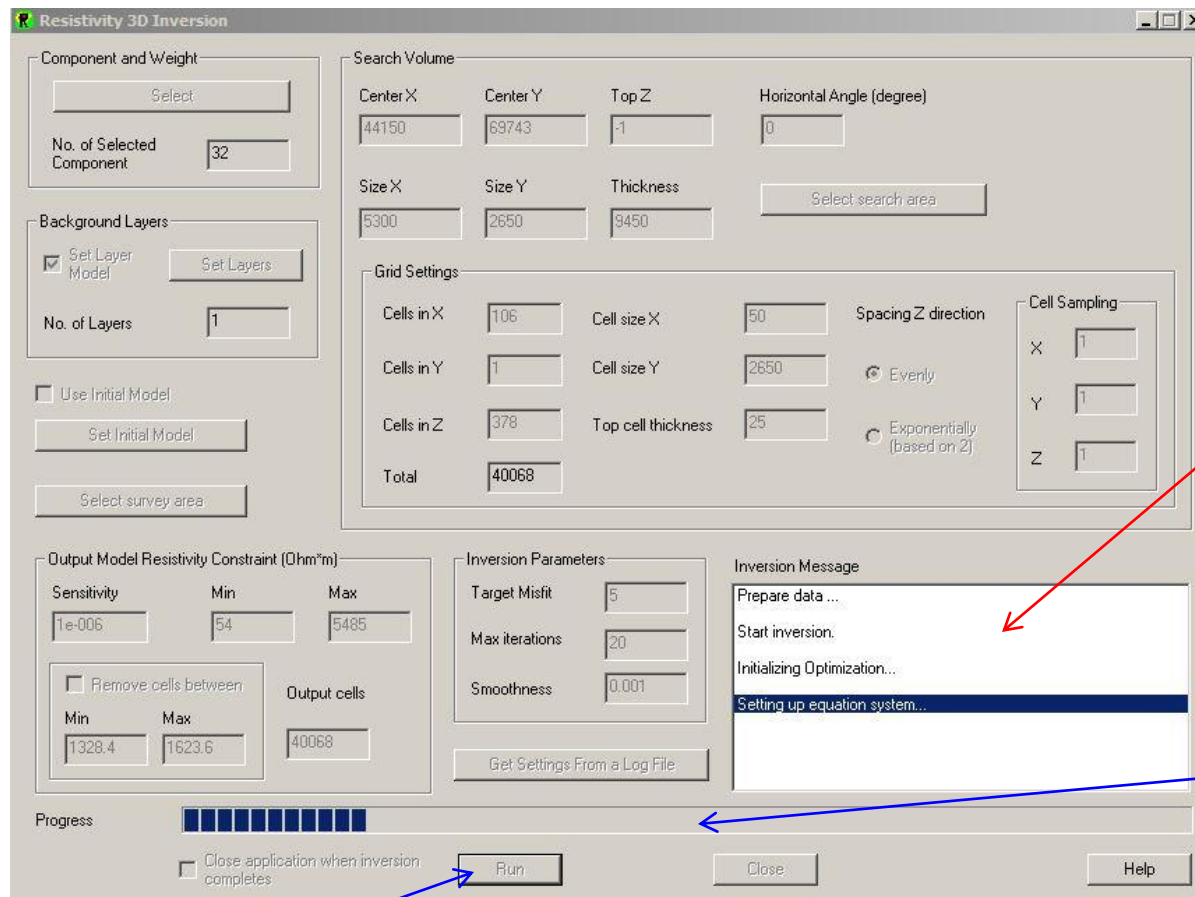
Select the prisms to be deleted in the anomaly list.
 Click **Delete all selected prisms**

import a model from another data set in the current database

Click **Import a model**.
 Select the project, survey, and data set with the desired model
 Click **OK** and the model will appear in the **Initial Model**.

1. Import data
2. Examine data
3. Perform initial modeling
- 4. Perform 3D resistivity inversions**
5. Check model and create plots

Executing the Inversion



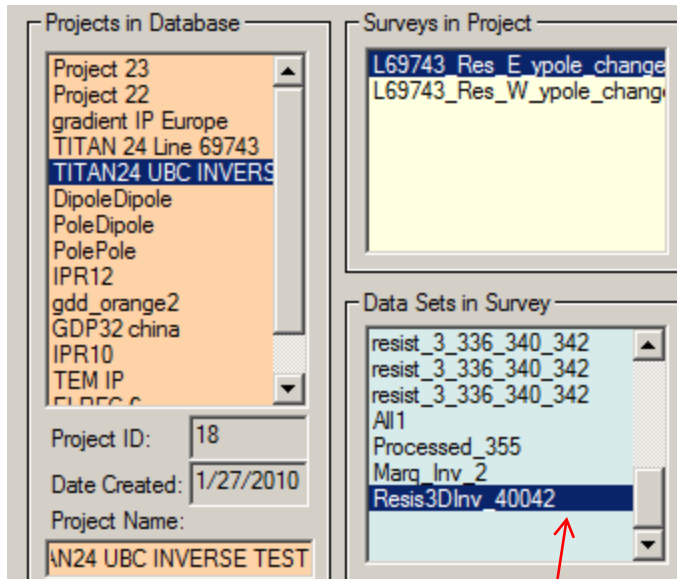
The right window (in white) shows each data point's progress.

The "Progress" bar shows the total progress of this inversion.

Click "Run" button to start inversion

1. Import data
2. Examine data
3. Perform initial modeling
4. Perform 3D resistivity inversions
- 5. Check model and create plots**

Inversion Evaluation

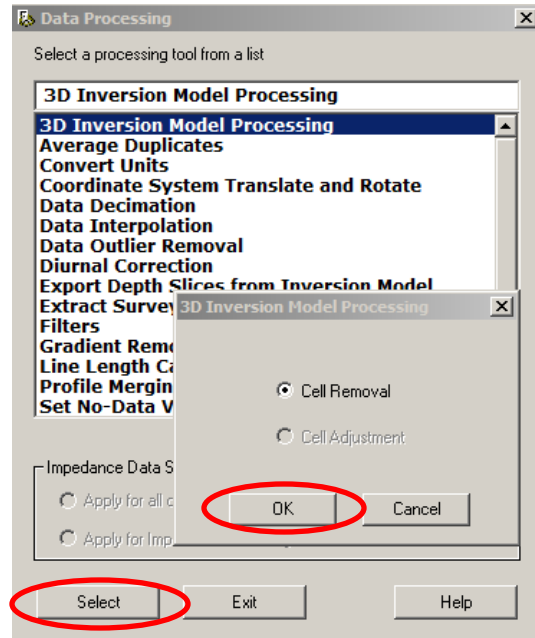


In each survey, there will be several data sets after modeling, inversion and processing. In this case, we have several forward models, one 1D inversion model (Mar_Inv_2, achieved from 1D inversion) and one 3D inversion model (Resis3DInv_40042, as highlighted). Each forward model has a new data set containing the simulated data under the model. Similarly, each inversion contains a new dataset containing the simulated data set under the inversion model (for each point) and attached to that data set is the inversion model.

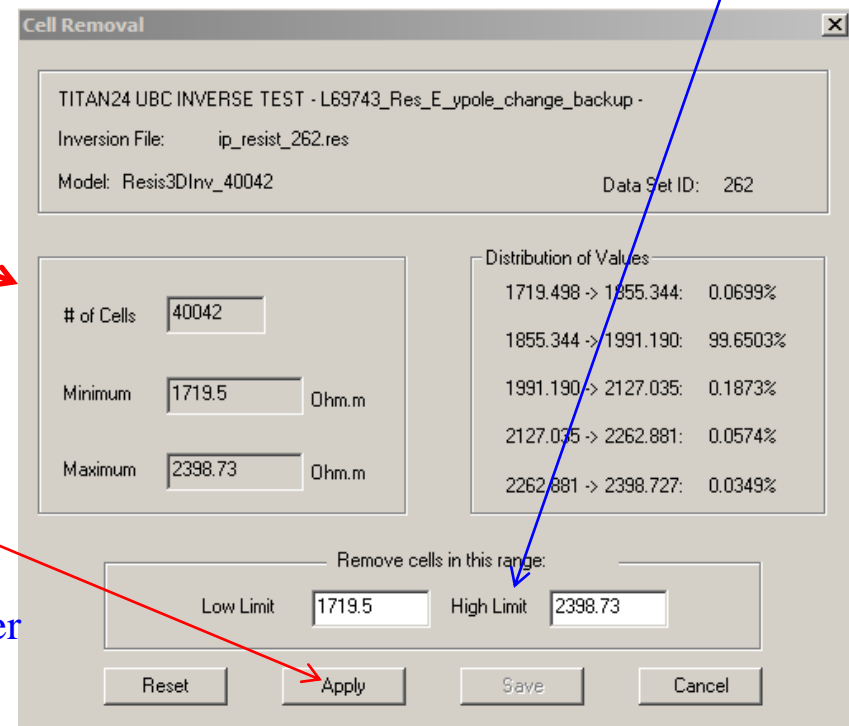
Our 3D inversion model dataset

1. Import data
2. Examine data
3. Perform initial modeling
4. Perform 3D resistivity inversions
5. Check model and create plots

Inversion Evaluation



Users can use “3D Inversion Model Processing” tool to remove cells in inverted model. Follow the routine shown in this page and arrive “Cell Removal” dialog. Choose the removal range of cells: “Low Limit” and “High Limit” (any cell within this range will be removed)



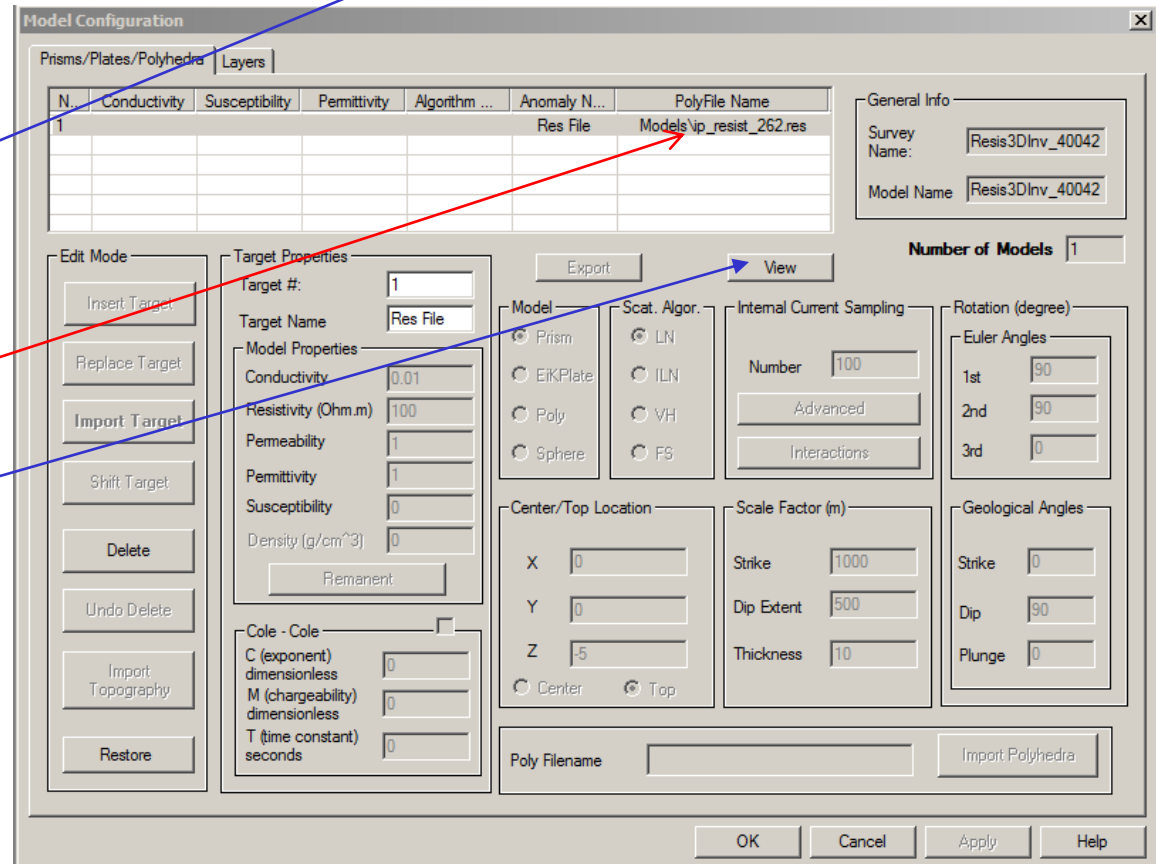
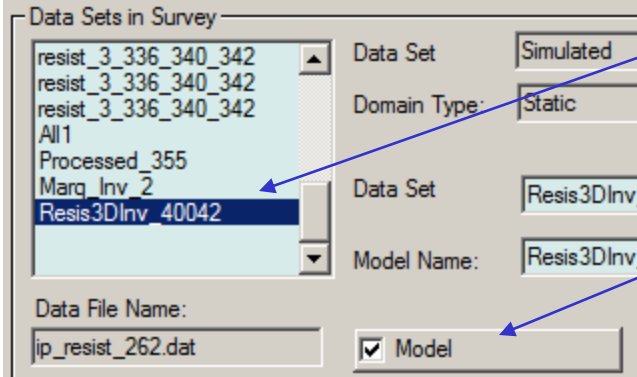
Click “Apply” button when it is done

Therefore, users can reduce the range of model either before inversion (by Select Search Area) or after inversion (by Cell Removal)

Inversion Evaluation

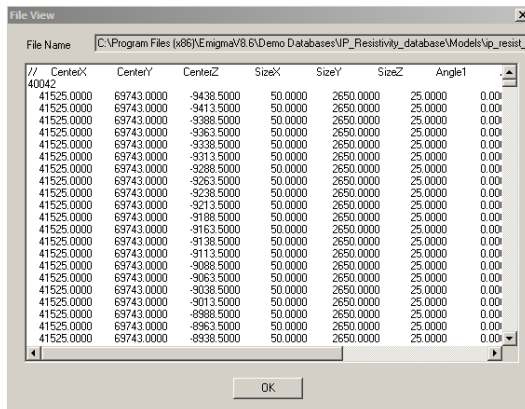
1. Import data
2. Examine data
3. Perform initial modeling
4. Perform 3D resistivity inversions
5. Check model and create plots

An inversion is selected. You will note the “Model” button is checked. If the “Model” button is clicked...



The model will be saved as a “Res File” with its name and folder shown in the “PolyFile Name” column of the table

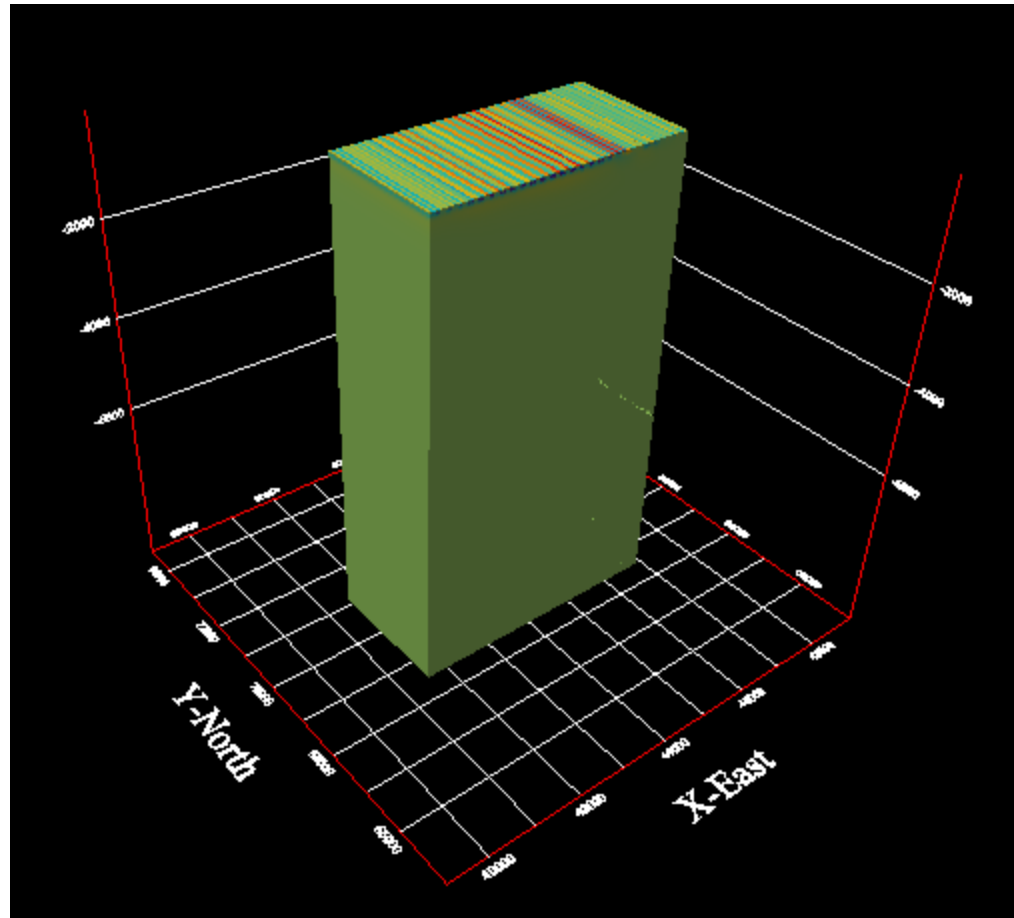
Click “View” button to open this file...



1. Import data
2. Examine data
3. Perform initial modeling
4. Perform 3D resistivity inversions
- 5. Check model and create plots**

Inversion Evaluation

Click  button to open Visualizer tool to view the inverted 3D model...



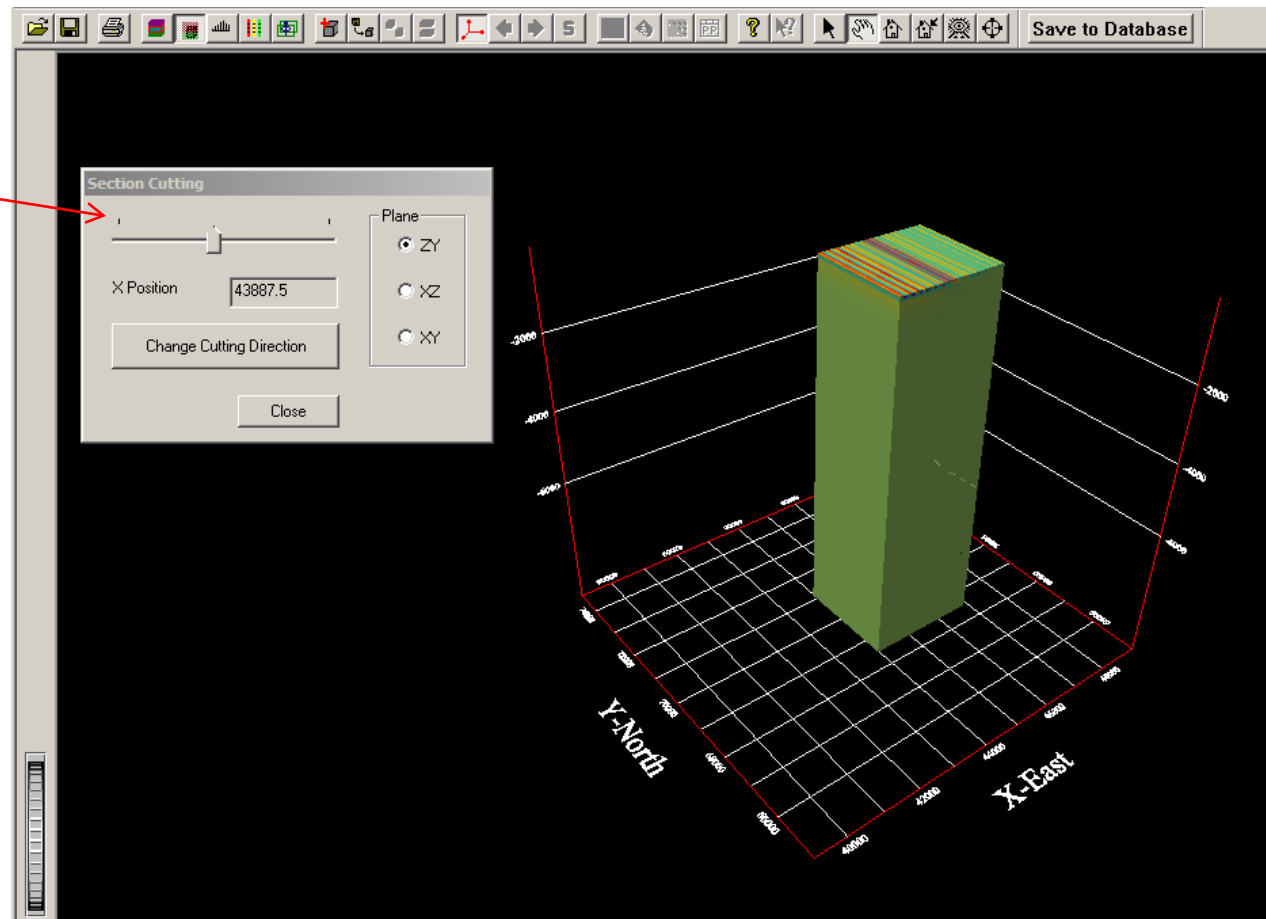
1. Import data
2. Examine data
3. Perform initial modeling
4. Perform 3D resistivity inversions
- 5. Check model and create plots**

Inversion Evaluation

Select from menu “Model -> Mag/Grv/Res File -> mag/grv/res Cutting” to open the Section Cutting tool.

By adjusting the bar...

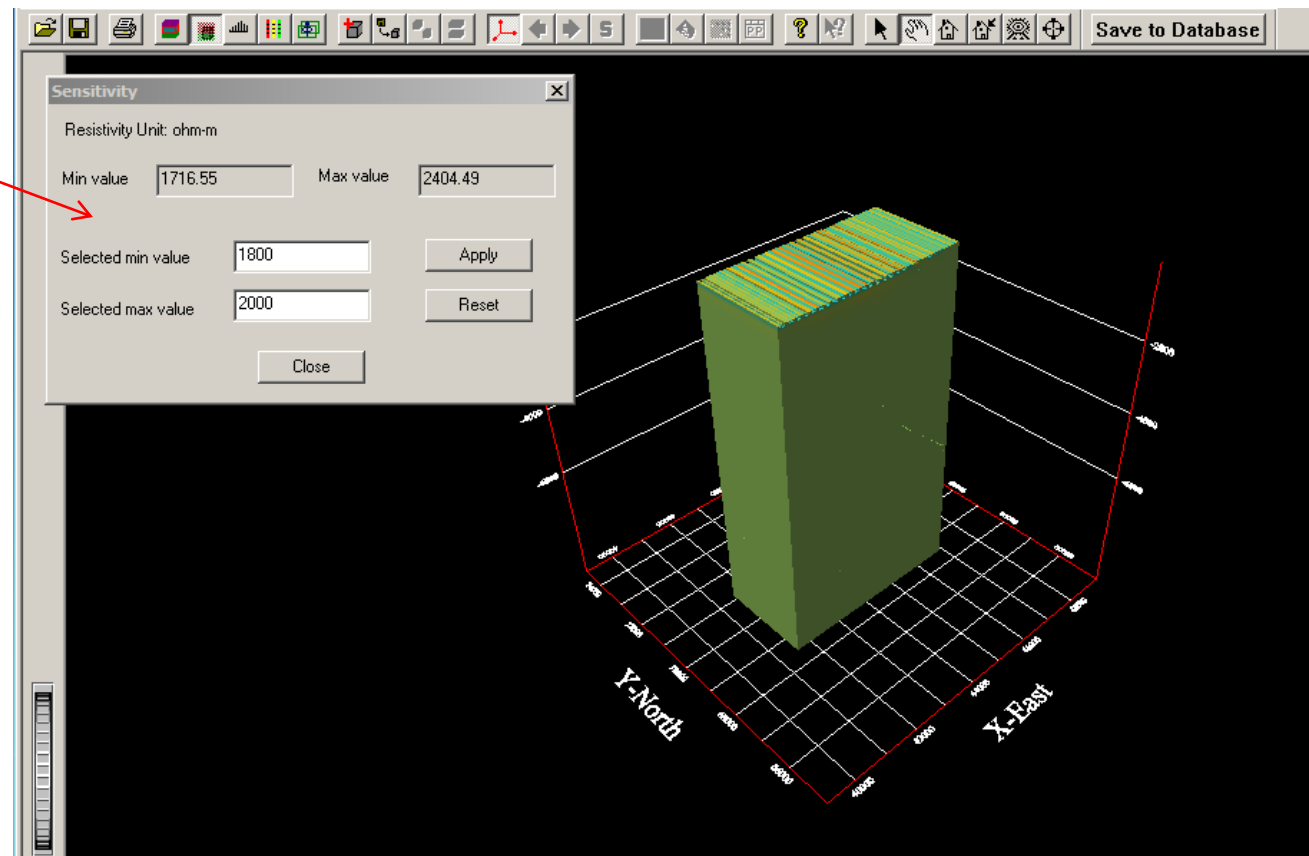
User can view sections of the 3D model from XY, XZ and ZY planes with any penetration depth



1. Import data
2. Examine data
3. Perform initial modeling
4. Perform 3D resistivity inversions
- 5. Check model and create plots**

Inversion Evaluation

Select from menu “Model -> Mag/Grv/Res File -> Sensitivity” to open the Section Cutting tool.



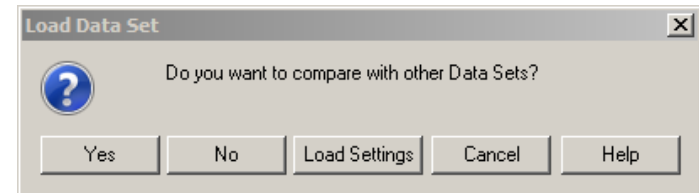
By adjusting minimum value and maximum value shown in the figure...

The model in this figure will only exhibit cells with values specified in this range

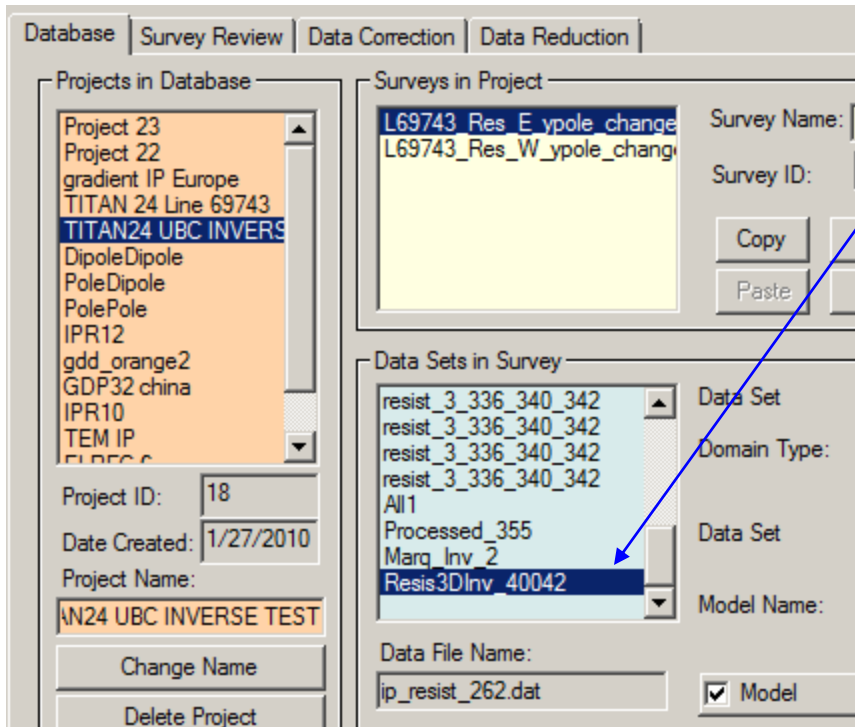
1. Import data
2. Examine data
3. Perform initial modeling
4. Perform 3D resistivity inversions
- 5. Check model and create plots**

Inversion Evaluation

To assess how well the inversion model fits the data at each station, select the inversion data set and then select the plotter.



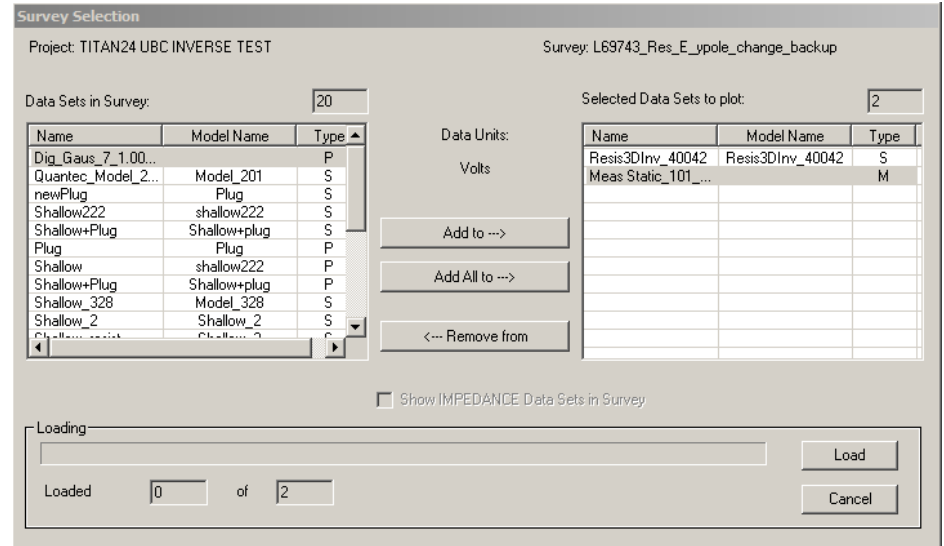
Select "Yes", if this dialog is appeared



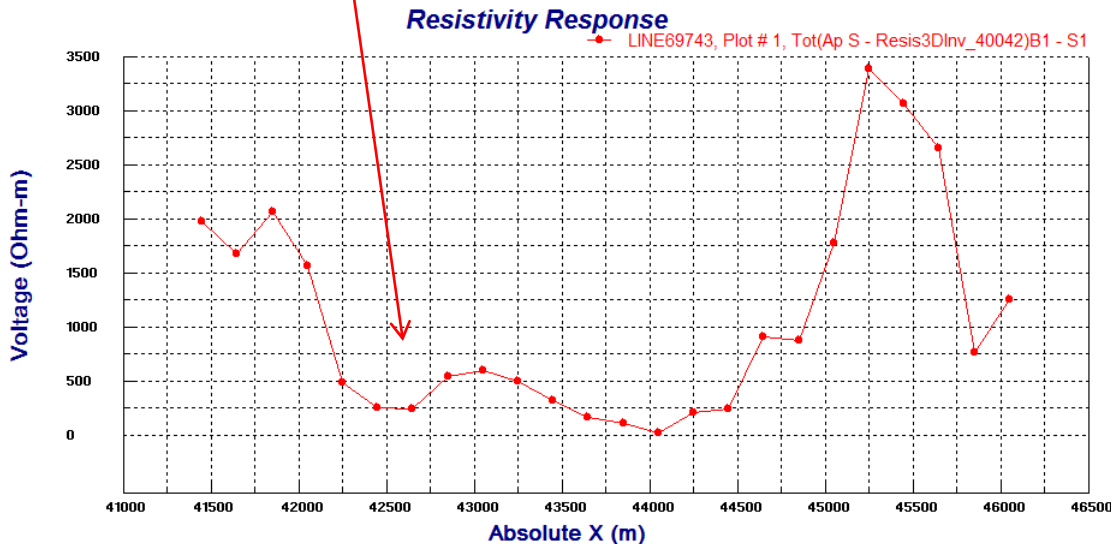
Inversion Evaluation

Select the data sets required for comparison and then click “Load”

1. Import data
2. Examine data
3. Perform initial modeling
4. Perform 3D resistivity inversions
5. Check model and create plots

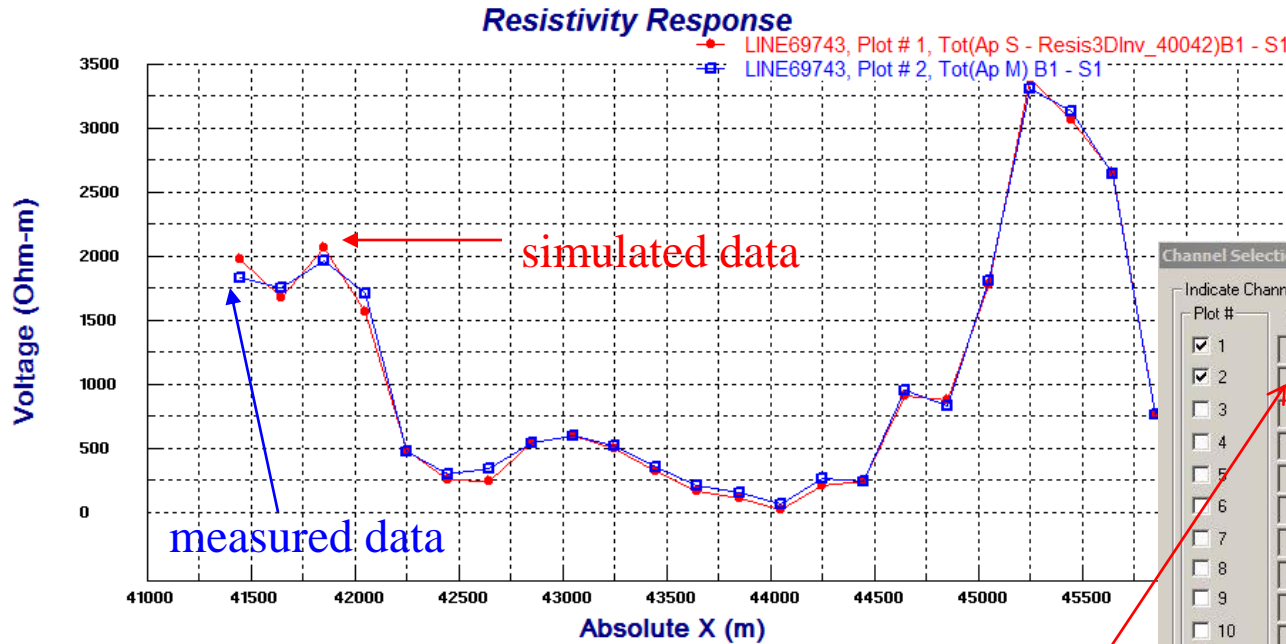


All selected data sets are then loaded to the Plotter application and the plot appears showing the simulated data of the first separation.



- 1. Import data
- 2. Examine data
- 3. Perform initial modeling
- 4. Perform 3D resistivity inversions
- 5. Check model and create plots

The user may select other data sets to plot by simply double clicking on the plot



The "Channel Selection" dialog box is shown on the right. It has a "Channel Selection" title bar and a close button. The "Indicate Channels" section has a list of 15 plots, with plots 1 and 2 checked. The "Field" column has dropdown menus for each plot, with plot 2 set to "Static". The "Selections for Plot 1" section has "Abscissa" set to "X-axis", "Data Kind" set to "Voltage", and "App Resistivity" checked. The "FEM Resistivity" section has "Real" selected. The "Reference Point At" section has "Center" selected. There are buttons for "Clear All Selections", "General Information", "OK", "Cancel", and "Help". A red arrow points from the text "Select for the 2nd plot on measured data" to the "Static" dropdown menu for Plot # 2.

Select for the 2nd plot on measured data

1. Import data
2. Examine data
3. Perform initial modeling
4. Perform 3D resistivity inversions
5. Check model and create plots

Inversion Evaluation

Resistivity Inverse
25

Multiple plots can be shown for various inversions and models in “Static” mode. The user may step through different separations by simply clicking the arrow.

